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Safety Concerns and Solutions Related to Solvent Distillation

Recovering solvent through distillation is an excellent method for companies with low to extremely high solvent use to reduce operating costs. Businesses can recycle their own waste solvent to reduce the cost of waste disposal and replacement solvent as well as lower their environmental liabilities in a safe manner by using the proper equipment.

Solvent distillation involves sufficiently heating waste solvent to cause the solvent to boil. The evaporated solvent separates from the waste to be cooled and collected for reuse. Safety related concerns can vary based on the solvent and waste type. A variety of safety concerns and solutions are described herein.

Class I Division I MetLab Certification

MetLab Safety Certifications are widely accepted by regulatory authorities in North America at the federal, state/provincial and local level as a standard of safety for equipment used in hazardous conditions. The certification is designated by a Class and a Division which describe the operational environment in which equipment can be used.

Class I designates that equipment can be used in a location made hazardous by the presence of flammable gasses or vapors present in the air in sufficient quantities to produce and explosive or ignitable mixture. Division I designates equipment to be operated in a location that will likely have hazardous condition under normal operation.

To reach Class I Division I standards, Maratek Environmental's solvent recovery equipment are built and certified to Class 1, Division 1 using motors, electrical components and parts that also have Class I Division I classifications. Our equipment is also compliant and certified with Class I and Division I CSA safety standards.

High Pressure and High Temperatures in the Distillation Chamber

Depending on the application, solvent distillation systems are designed to safely operate at a variety of pressures (positive and negative) and temperatures. With vacuum assisted distillation systems, the operational pressure is usually under atmospheric pressure ie. negative pressure. With fractional column distillation systems, the operational pressure is positive in order to guide the solvent vapor up the column more efficiently. The ideal pressure and temperatures to operate at varies based on the system and solvent being processed. Pressure increases can be caused by the rare blockage of the tube used to collect the solvent fumes to carry them to the condenser. Blockages can also occur rarely due to improper filling of the chamber, improper cleaning of the tube and high levels of foaming of the solvent.

Maratek Environmental's systems are equipped with pressure and temperature sensors to proactively detect and turn off the system automatically should any over-pressure or over-temperature situation occur. For further safety redundancy, there is also a pressure release valve or seal to mechanically avoid over pressurization which vents the excess vapor/pressure to proactively and safely release the pressure. In such an event, the system should be stopped immediately and an analysis on the cause of the pressure increase along with any required repairs must be done before the system can be used again. The safety valve and cover should never be blocked or covered. If the valve of seal is opened, there could be a certain volume of relatively high temperature solvent in liquid and/or gaseous form to escape the chamber which could be a safety concern. Depending on the system design, the vapor can be vented to a collection drum, another room or outdoors if needed or required.

Solvent Foaming

During normal operation all solvents will produce some foaming. To ensure the collection tube is not blocked and to maintain distillate purity, the foam level should never reach the collection tube leading from the chamber to the condenser.

To prevent issues caused by solvent foaming Maratek Environmental's solvent recovery systems are designed with additional volume in the boiling chamber to allow solvents space to foam.

The level of foaming varies based on the solvent waste being processed, the pressure at which distillation is performed, physical properties of the solvent, physical properties of the waste and the temperate of distillation. In cases of very high levels of foaming these steps can reduce the level the foam reaches in the chamber.

- Allow the solvent waste to rest for 48 hours before processing
- Do not fill the chamber to capacity to allow more free space during distillation
- If possible, reduce or remove vacuum assistance
- If possible, reduce the temperate settings of the equipment
- Use anti-foaming discs within the chamber
- Use anti-foaming solutions, this can dramatically influence the production rate of the system

Temperature Increase During a Drying Phase

Depending on the type of solvent waste being processed, a second heating phase may be employed to increase the solvent yield. This is often called a drying phase because the waste remaining dries out into a solid or powder depending on the type of system and the application. The Material Safety Data Sheet must also be consulted to confirm the solvent will not decay at a higher temperature.

The temperature increase poses two possible safety concerns. The higher temperature may allow chemical reactions to occur that would not be possible at lower temperatures. The properties of the waste and solvent should be understood to avoid this issue as well as acidification of the waste during drying which can damage the boiling chamber and reduce the quality of the distillate. A common reaction to be aware of is nitrocellulose combustion which is described below.

The second safety concern is the overall heating of the system. This is a potential issue during normal operation as described above but the safety concerns increase somewhat during high temperature drying. The boiling chamber of Maratek Environmental's recovery systems are insulated but the outside temperate of the system will still increase during operation, particularly the lid. While the system is in operation or in a cooling phase, the system should not be touched by associates. Vacuum assisted drying can be used to lower the effective boiling point to mitigate the risk if required. The manual for individual systems should be consulted for more detailed information.

Heating Jacket Malfunction

Maratek Environmental's solvent recovery systems usually employ a heating jacket with either heating oil or steam to heat the boiling chamber. The oil or steam is set to a certain temperature depending on the solvent that is being processed. In rare cases, the temperature in the jacket can exceed the set temperature and over heat the solvent. To avoid this issue there is also a temperature probe within the boiling chamber, if the solvent temperature begins to overheat the system will automatically shut down to avoid damaging the solvent or generating any dangerous reactions.

Nitrocellulose Reactions

Nitrocellulose is an ester of cellulose and nitric acid and is sometimes used in inks, coatings and paints. The amount used depends on the individual product but usually ranges between 2%-30%. Nitrocellulose is a solid that becomes unstable at temperatures above 320° F (160°C) and can also react or decompose exothermically, resulting in toxic fumes including oxides of nitrogen and carbon monoxide. Atmospheric oxygen should not be introduced during operation as it may cause the decomposition to combust. If a nitrocellulose reaction occurs, the room should be evacuated and vented until completed.

A variety of safety features can be used to safely manage nitrocellulose wastes. These include vacuum assisted distillation, steep cone shaped walls within the boiling chamber, internal scrapers in the boiling chamber, temperate controls to monitor the internal temperature and automatic cooling systems to rapidly cool the sludge. Further information about nitrocellulose related safety and features can be found in Maratek Environmental's Whitepaper titled Distilling Nitrocellulose Waste Solvent Safely.

Solvent Properties

During distillation the solvent waste can be heated to high temperatures, the properties of the solvent and waste must be understood to avoid related safety issues. Most solvents have a flash point and an auto-ignition point. At the flash point, a solvent will readily ignite at the presence of a spark or flame. It can be acceptable for a solvent to exceed this temperature within the distillation chamber since all Maratek Environmental solvent recovery systems are Class I Division I certified to prevent sparks. This was explained previously in this document.

At the auto-ignition point a solvent will spontaneously combust in the presence of oxygen and this occurs very rarely. To avoid automatic ignition, the surface temperature within the boiling chamber must be lower than the automatic ignition point. Both the flash point and automatic ignition points should be available on the Material Safety Data Sheet for the solvent and should be reviewed before processing. Please contact Maratek Environmental if you have any questions regarding any safety related issues or concerns and our engineering group would be happy to assist to ensure the recycling of the solvent is done safely.

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